Facilitating the creation of synergies between OHS and Productivity - The implementation of lean tools

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Abstract
This study aims to identify implementation pattern or sequence of lean and OHS practices in a group of garment manufacturers in Bangladesh. We run two-step cluster analysis on a group of 50 garment manufacturers in Bangladesh. For lean, we find that technical practices are more relevant for predicting the membership in a cluster, while for OHS, human resources practices play a more decisive role. Yet, we find that, in both lean and OHS domains, clusters with high maturity level and high intensity of implementation of practices are mostly populated by large plants.

Keywords
Sustainable operations; workplace practices; bundles of practices, Occupational Health and safety; lean manufacturing.

Introduction
The literature emphasizes that bundles of reinforcing HR and manufacturing practices are likely to enhance performance, as they provide several ways for workers to acquire skills and multiple incentives to boost their motivation (Macduffie, 1995). In the continuous improvement and lean literatures, authors have argued that leadership commitment, communication and support are crucial for sustaining the improvement in the organizations (Imai, 2012; Womack and Jones, 1996). In this context, authors have argued that an exclusive focus on the technical tools is likely to have short-term benefit and fail to sustain the improvements. As for the safety literature, there is evidence that safety management systems based on commitment to safety, training, employees' involvement, and control are more likely to enhance safety performance in organizations (Fernandez-Muniz et al., 2007). Moreover, Dejoy (2002) have mentioned the need for both behavioural bottom up and cultural top down approaches for managing safety.

While the available studies agree that a bundle of practices is more effective than individual practices, the literature contains much less insights regarding whether companies should implement all practices within a bundle in parallel or sequentially. In this context, the literature indicates that organizations follow a predictable pattern, which can be characterized by stages of development (Greiner, 1972). Yet, although the different stages might not be connected in any deterministic sequence, they are internally coherent and different from one another (Miller and Friesen, 1984). Moreover, diffusion of innovative practices refers to the spread of concepts,

technical information and actual practices within a social system (Rogers, 1983). This is reflected in the operations management literature, which posits that there is a pattern in the evolution of manufacturing practices, so that firms can be classified according to their adoption stage of manufacturing and operational practices (de Menezes et al., 2010).

Among the few studies focusing on the implementation sequence of practices, Imai (2012) has mentioned that some practices such as standardization, housekeeping, and the elimination of waste should precede other practices because they form the foundations for building sustainable improvement capabilities. In this paper, we aim to contribute to this field by investigating the pattern of implementation of lean and Occupational Health and Safety (OHS) practices in a group of 50 garment manufacturers in Bangladesh. The investigation of lean and OHS practices in an indsutrializing country is interesting as most available studies are based on cases from industrialized and developped countries (Pagell et al., 2015). Indeed, it is likely that the institutional context and industrial tradition imply different views regarding the improvement of OHS conditions for workers at the shop floor. In this study, we use the two-step cluster analysis as an exploratory technique in order to identify clusters of manufacturers and the associated practices related to lean and OHS in each cluster. The maturity levels of OHS and lean, and plant size are used for evaluative purpose and do not enter in the clustering algorithm. By doing so, we are able to identify the pattern of implementation of lean and OHS practices in different clusters associated with different maturity levels and different plant size. In the next sections, we present the research methodology, results, discussion, and conclusions.

Methodology

Selection of companies

Fifty (50) garment manufacturers were identified through the snowball technique (Biernacki and Waldorf, 1981) associated with a set of selection criteria. That is, all manufacturers are members of BGMEA (Bangladesh Garment Manufacturers and Exporters Association) and export 100% of their production. The manufacturers are located in Bangladesh's two main garment hubs: Dhaka and Chittagong. Due to the relevance of plant size on the adoption of workplace practices (Shah and Ward, 2003), the sample contains plants of different sizes, which is defined according to the number of employees (Table 1). It is important to mention that, although large companies can involve many plants with headquarters and many thousands employees, the level of analysis is the plant not the corporate company. Plant size is recoded into ordinal ranks: small (rank 1), medium plants (rank 2), and large plants (rank 3).

Table 1 – Sample distribution by plant size

Number of plants according to size			**Total**
Small (rank 1) <500 employees	Medium (rank 2) 500-2000 employees	Large (rank 3) >2000 employees	
8	19	23	50

The identification and assessment of practices

In order to identify the practices related to OHS and operational practices, we draw on the work of Peng et al. (2008), who focus on bundles of practices (referred as improvement capabilities) and define these bundles according to three dimensions: leadership involvement and attitudes, process focus and continuous improvement. These bundles of practices or capabilities are inspired by the process focus movement and have generic features that can be applied to both domains (OHS and lean).

As for the practices related to lean, we draw on the lean manufacturing and continuous improvement literatures (Imai, 2013; Monden, 1983; Womack and Jones, 1996; Bessant et al., 2001). In order to capture the peculiarities of practices related to OHS, we draw on the safety

literature (DeJoy, 2005; Fernandez-Muniz et al., 2007; Parker et al., 2006). The practices related to OHS and lean are presented respectively in Tables 2 and 3. The practices encompass both technical and behavioral dimensions. The assessment model of these practices consists of five levels ranging from reactive application to systematic continuous improvement of practices. In Tables 4 and 5, we give two examples of assessment according to the five-step progression (reactive, formal, deployed, autonomous, way of life) of two practices: "Leadership Commitment and Communication" for OHS and "Leadership Support and Commitment" for lean. As such, we attribute a score (1 to 5) for each dimension according to the maturity of the plant.

Table 2: The bundle of practices underlying OHS and lean

OHS practices	Lean practices
Leadership commitment and communication	Leadership support and commitment
Business Policy	Employee involvement
Relation with contractors	Training
Relation with buyers	Continuous improvement
Objectives, Targets & Performance Measurement	Value stream mapping
Training	Control through Visibility
Workforce Involvement	Accounting support to Lean
OHS structure and accountability for OHS results	5S/housekeeping
Accident Investigation	Preventive maintenance
Unsafe Behaviors and Unsafe Work Conditions Reporting	Structured Flow/Pull Manufacturing
Legal requirements, Auditing and Reviews	

Table 3: An example of the five-step progression for the assessment of one OHS practice: "Leadership Commitment and Communication"

Reactive	**Formal**	**Deployed**	**Autonomous**	**Way of life**
Leadership Commitment and Communication				
Responsibility for accidents is seen as belonging to those directly involved. The priority is to limit the damage and get back to production. Management is not interested apart from telling workers not to cause problems.	The leadership sees OHS compliance as one of the goals of the business. The responsibility of the system for accidents is considered but has no consequences. The "flavor of the month" safety message is passed down from management. Any interest diminishes over time as things get "back to normal".	OHS compliance practices and goals are communicated in the organization. There is increase in awareness. There is consistent leadership follow up for implementation.	Management look at the whole system, including processes and procedures when considering accident causes. Investigation focuses on underlying causes and the results are fedback to the supervisory level. It is admitted that management must take some of the blame. Managers realize that dialogue with the workforce is desirable and a two-way communication process is in place.	The responsibility of OHS compliance is distributed among all employees and managers. People take a broad view looking at the interaction of systems and people. There is a definite two-way process where management gets more information back than they provide.

Expert assessment

In this study, the assessment of the maturity of each dimension is based on expert assessment rather than self-reported data. In the literature, attempts to investigate workplace practices have been based mainly on self-reported and perceptual data rather than on expert assessment (Håkansson et al., 2017). By including expert assessments and triangulating data from different sources, we increased the validity of our results and avoided the methodological problems introduced when relying only on self-reported data (Håkansson et al., 2017). Moreover, during the development of the methodology, experts (consultants, managers, and researchers) from Bangladesh and Denmark reviewed the assessment procedures and scales. The experts from Bangladesh focused on the operational applicability of the assessment and the interview guides, in order to adjust them to match the Bangladeshi context. These experts are operations managers or professionals from international or local labor unions or NGOs related to the garment industry in Bangladesh. The experts from Denmark focused particularly on the research method (assessment model, scoring, and validity and reliability issues). The assessment methodology was adjusted to take into account the experts' comments.

Calculation of the aggregate score for OHS and lean

The model consists of 12 practices for OHS and 11 practices for lean. We allocated an ordinal rank for each of the five levels (reactive: rank 1; formal: rank 2; deployed: rank 3; autonomous: rank 3; way of life: rank 5). The aggregate score of the plant (the maturity level of the plant) was calculated by averaging the individual scores of all practices to obtain one single numerical score for each company (see Table 6 for an illustrative example). As such, each of the 50 companies gets two scores: one is related to OHS practices (maturity level for OHS) and the other is related to lean practices (maturity level for lean). This conversion method (calculate the average of ordinal numbers) has been previously used in the operations literature (Huq et al., 2016). Moreover, we have relatively high number of dimensions (11 for lean and 12 for OHS) rendering this conversion less problematic.

Table 4: Illustrative example from one company for the calculation of the aggregate score (maturity level)

Practices related to lean	**Score**
Leadership support and commitment	3
Employee involvement	3
Training	2
Continuous improvement	2
Value stream mapping	3
Control through Visibility	2
Accounting support to Lean	1
5S/housekeeping	3
Preventive maintenance	3
Structured Flow/Pull Manufacturing	3
Aggregate score (average)	2,27

Data collection in companies

Data collection was carried out by three teams of researchers from Ahsanullah Science and Technology University (AUST) in Bangladesh in collaboration with three researchers from

Aalborg University (AAU). Each team consisted of a senior (professor/associate professor) researcher, a PhD student, and a research assistant. The data for the 50 garment manufacturers were collected over the period of a year (from June 2015 to June 2016). Suppliers were first contacted by telephone, and the first introductory meeting was scheduled during that call. Cold calls were avoided as they have a very low response rate in Bangladesh. The data collection involved two to three visits to each supplier including the introductory visit. First, the research team conducted the introductory visit. The purpose of the introductory visit was to secure the necessary social ties and consent from the company managers, plan the subsequent data collection, collect the first basic information about the company, and get an overview of the production set-up. The introductory meeting with the supplier covered the following topics: presentation of researchers, presentation of project, expectations of the company, an offer to give researcher feedback to the company, a promise of confidentiality, the collection of basic information, a short tour round the company, and the plan for data collection.

The main data collection for the assessment of capabilities took place as soon as possible after the introductory visit, and lasted one full day. The purpose was to collect the main bulk of information from the company and to score the dimensions of practices related to OHS and lean. To triangulate between different data sources, the researchers collected evidence covering numerical measurements and indicators of lean and OHS, minutes of meetings (safety committee meetings and others), copies of the company's policies and norms, descriptions of projects and programs, training material, and operating procedures. Moreover, semi-structured interviews were held with managers representing the different organizational functions. For assessing of the maturity level of OHS, the team interviewed safety/compliance manager and his team. As for the assessment of the maturity level of lean, production managers and supervisors were the main source of data. As such, we avoided that the assessment of the maturity levels of OHS and lean are based on data obtained from the same informants.

Validity and generalizability of the results

The three data collection teams initially received two days of training related to the assessment methodology. Subsequently, two companies were used for pilot testing and training. In the pilot phase the interview guides were tested, the method adjusted, and the assessment criteria fine-tuned. In addition, all the participating researchers carried out a full assessment of maturity level of OHS and lean, and the coefficient of inter-rater reliability (ICC) of the different team members involved in the assessment was calculated. The ICC in the pilot phase was 0.818. The measurement of this coefficient was repeated, and it reached 0.92 during the main data collection period. For each company, the PhD student and the research assistant carried out the initial assessment, and this was subsequently checked by the senior researcher. Afterwards, quality control was carried out by AAU researchers, who checked the consistency and completeness of the data for each of the 50 companies. Moreover, while the focus on one industry might limit the statistical generalizability of the results, it can increase the validity of our findings. Indeed, the criteria adopted in this study for selecting the group of manufacturers account for the following contextual factors, which enhances the validity and the comparability of the results across companies:

-Industry type / Product type:

All the 50 companies are export-oriented and are members of BGMEA (Bangladesh Garment Manufacturers and Exporters Association). The main activity of all the companies is sewing basic ready-made garments.

-Ownership structure:

All the 50 companies are family-owned and share a similar management culture. In a typical family-owned company in Bangladesh, one or more family members are responsible for the daily management of the company and retain most of the important business decisions.

-Unionization:

The unionization of workers in the garment sector in Bangladesh is very low as trade unions suffer from acute lack of credibility among factories owners and public in general (McKinsey & Company, 2011). As such, the effect of "unionization" on the empirical results can be safely ignored.

Results

We run the two-step cluster analysis in SPSS by taking the 12 practices of OHS and the 11 practices of lean as input. The two-step cluster analysis is a combination of the two traditional cluster analysis (K-Means and Hierarchical Cluster analysis), can handle scale and ordinal data in the same model and allows for the automatic selection of the number of clusters. These proprieties fit our needs of analyzing ordinal data and selecting the number of clusters (without necessarily forcing a pre-selected number of clusters). The average score and plant size are used for evaluative purpose and do not enter in the clustering algorithm. In the first round (not shown in this manuscript because of the limited space), we try to force 3 clusters for OHS and lean and we obtain poorly informative clusters for lean (size ratio between the biggest and smallest cluster rises to 7.5 while the recommended ratio is below 3). In the second round, we do not limit the number of clusters in SPSS and we obtain 3 distinct clusters for OHS and 2 distinct clusters for lean. Moreover, as we take into consideration the importance of predictors for the clustering results, the top 3 predictors are "5S", "Structured flow", and "Value stream mapping" for lean (Table 5), and "OHS structure and accountability", "Business policy", and "OHS target, performance and measurements" for OHS capabilities (Table 6).

Table 5: Results of two-step cluster analysis of lean practices

Cluster	**1**	**2**	**Predictor impor-tance**
Cluster Size	67,4% (31)	32,6% (15)	**High**
Inputs	5S 3 (48.4%)	5S 4 (80.0%)	
	Structured Flow 2 (87.1%)	Structured Flow 3 (80.0%)	
	VSM 1 (83.9%)	VSM 3 (40.0%)	
	Buyer/Supplier relationships 3 (64.5%)	Buyer/Supplier relationships 4 (73.3%)	
	Continuous improvement 2 (71.0%)	Continuous improvement 3 (73.3%)	
	Preventive maintenance 3 (90.3%)	Preventive maintenance 4 (73.3%)	
	Control through visibility 2 (51.6%)	Control through visibility 3 (73.3%)	
	Employee involvement 2 (80.6%)	Employee involvement 3 (60.0%)	
	Training 2 (67.7%)	Training 3 (66.7%)	
	Leadership commitment 3 (48.4%)	Leadership commitment 3 (73.3%)	
	Accounting support to lean 1 (48.4%)	Accounting support to lean 2 (66.7%)	**Low**
Evaluative fields	Plant size Medium (48.4%)	Plant size Large (93.3%)	

	Maturity level lean (2.15)	Maturity level lean (3.19)	

In Table 5, we can observe that Cluster 2 contains plants that have higher level of implementation of lean practices than Cluster 1. For example, Cluster 2 contains plants with level 4 (5S) as compared with level 3 (5S) for Cluster 1. Moreover, as we look at the evaluative felds, we can oberve that Cluster 2 contains plants of larger size and of higher maturity level of lean than Cluster 1. In Table 6, we observe similar pattern for OHS where Cluster 2 contains plants that have higher level of implementation of OHS practices than Clusters 1 and 3. Cluster 2 contains also plants of larger size and of higher maturity level of OHS than Cluster 1 and 3.

Table 6: Results of two-step cluster analysis of OHS practices

Cluster	**3**	**1**	**2**	**Predictor importance**
Cluste Size	67,4% (31)	32,6% (15)	19.1% (9)	
Inputs	OHS structure and accountability 3 (96.0%)	OHS structure and accountability 2 (92.3%)	OHS structure and accountability 4(100.0%)	**High**
	Business policy 3 (80.0%)	Business policy 2 (69.2%)	Business policy 4 (100.0%)	
	Objectives, targets and performance measurement 3 (84.0%)	Objectives, targets and performance measurement 2 (38.5%)	Objectives, targets and performance measurement 4 (88.9%)	
	Industrial relations, welfare and job satisfaction 3 (88.0%)	Industrial relations, welfare and job satisfaction 2 (53.8%)	Industrial relations, welfare and job satisfaction 4 (100.0%)	
	Workforce involvement 3 (84.0%)	Workforce involvement 2 (92.3%)	Workforce involvement 3(77.8%)	
	OHS Training 3 (84.0%)	OHS Training 3 (61.5%)	OHS Training 4 (88.9%)	
	Leadership support and commitment 3 (80.0%)	Leadership support and commitment 3 (61.5%)	Leadership support and commitment 4 (66.7%)	
	Legal requirements and auditing 4 (56.0%)	Legal requirements and auditing 3 (38.6%)	Legal requirements and auditing 4 (100.0%)	**Low**
	Relations with buyers 3 (48.0%)	Relations with buyers 3 (84.6%)	Relations with buyers 4 (88.9%)	
	Unsafe behaviors 3 (64.0%)	Unsafe behaviors 2 (53.8%)	Unsafe behaviors 3 (55.6%)	
	Accident investigation 2 (56.0%)	Accident investigation 2 (61.5%)	Accident investigation 3 (55.6%)	
Evaluative fields	Plant size Large (48.0%)	Plant size Small (53.8%)	Plant size Large (77.8%)	
	Maturity level OHS 2.83	Maturity level OHS 2.19	Maturity level OHS 3.48	

The association between the intensity of implementation of lean and OHS practices and the maturity levels and plant size is further supported by Figure 1.

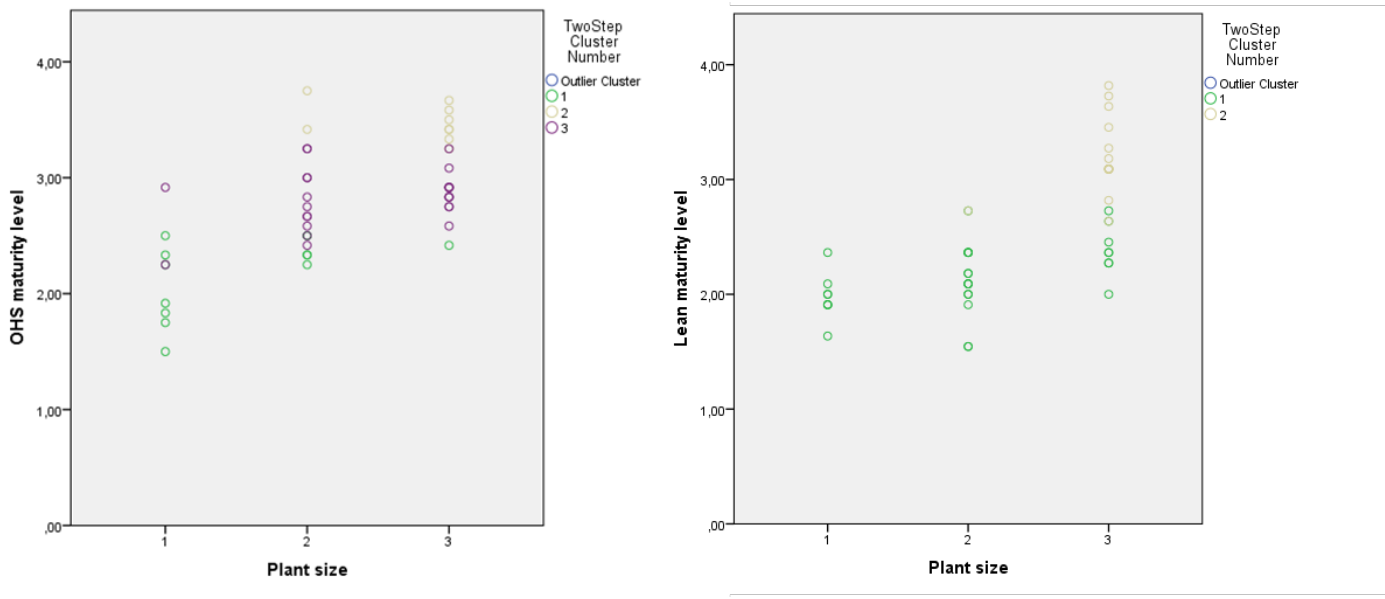

Figure 1: Scatter plot of maturity levels of lean and OHS versus plant size

Discussion and conclusions

The first finding of this study is related to the importance of 5S in predicting the maturity level of lean in a cluster. This finding is supported by (Imai, 2012), who argues that 5S should be implemented in the begining of lean transformation as it creates the foundations for improvement. As for OHS, it seems that HR practices (such as OHS structure and accountability and Business policy) are more important for predicting the maturity level than technical practices (such as Accident investigation and Unsafe Behavior reporting). It is possible that OHS is more dependent on accountability and top management support (Business policy) as there is evidence that corporate policies can easily encourage decoupled processes that have little impact on improving OHS conditions at the shop floor level (Weaver et al., 1999). The second finding of this study is related to the association of the implementation intensity of lean and OHS practices (maturity level) with plant size (Figure 1). That is, large plants are likely to implement more intensively OHS and lean practrices that small and medium plants, which support previous findings in the literature where large plants are more likely to implement innovative workplace practices (Levine and Roffel, 2010; Shah and Ward, 2003).

As contribution for theory, this study differs from similar studies in developping countries (Pagel et al., 2015) as plant size (availability of resoures) is likely to play an important role in the implementation of OHS practices. As contribution for practice, companies in developing and industrializing context are more likely to improve OHS conditions by implementing HR mechanisms that reduce the decoupling between corporate and shop floor practices. This is an exploratory study aiming to investigate the pattern or sequence of implementation of workplace practices in a group of garment manufacturers in Bangladesh (a single industry in one industrializing country). It is important that we test these findings through qualitative and quantitative explanatory studies in different contexts in order to obtain more robust knowledge regarding the implementation sequence of lean and OHS practices.

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